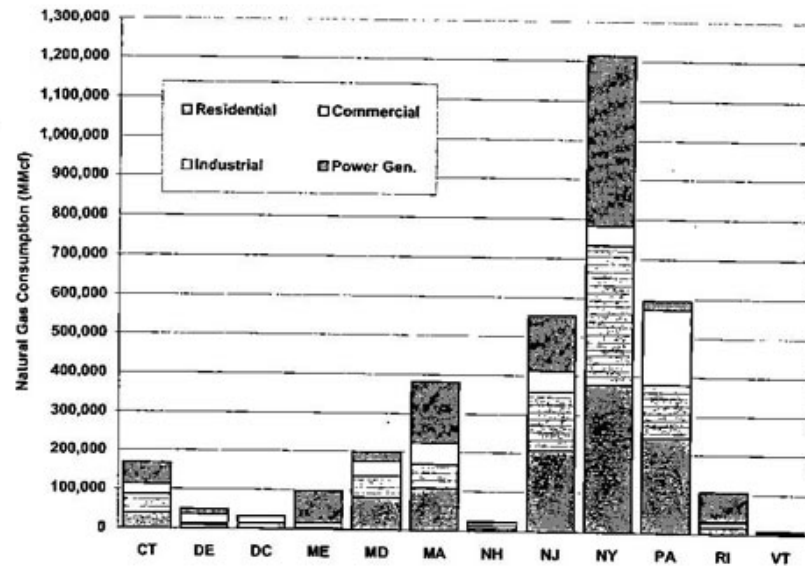


Figure 16. Natural Gas in the Northeast and Mid-Atlantic State in 2002 by Sector (EEA 2003)

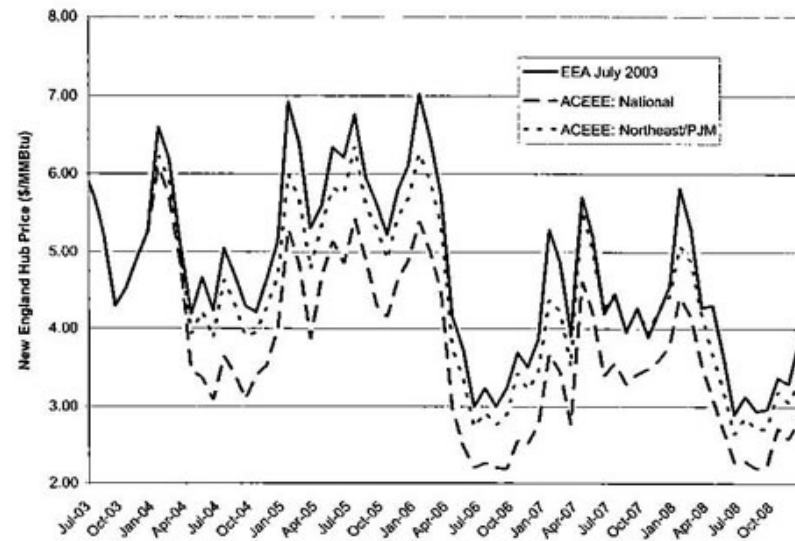


In the New England and Mid-Atlantic region we can compare the results for both the National and the New England and Mid-Atlantic scenario. As can be seen in Figure 16, the application of energy efficiency and renewable energy measures in the region achieve 32% of the price reduction seen with lower-48 state application of the measures. Similarly, we see about a third of the price reduction at the retail level (Figure 19).

In contrast to the Midwest where we see significant increases in industrial gas consumption as a result of avoided demand destruction, we only see modest increases in industrial consumption in Maryland and Pennsylvania, both noted for their gas dependent industries (see Figure 18). In eight of the states, the power generation sector experiences the greatest cumulative gas savings as a result of the combined effects of electric energy efficiency and conservation and expanded renewables. In the remaining jurisdictions, (D.C., Massachusetts, Rhode Island and Vermont), it is the residential gas conservation that contributes the greatest share to the total state gas reductions. The commercial sector also factors prominently in the gas reduction in these states.

The residential sector accounts for more than half of the cumulative natural gas expenditure reductions in seven of the states in the region (see Figure 20), while power generation accounts for more than half in Delaware, Maine and New Hampshire. The share of savings in the commercial sector is modest in all the states, while the industrial sector experiences significant natural gas expenditure reductions in Delaware, Maine, Massachusetts, Pennsylvania, and Vermont.

**Figure 17. Impact of Regional and National Application of Renewable Energy Efficiency and Renewable Energy Measures on Regional Wholesale Prices**



**Figure 18. Change in Natural Gas Consumption in the Northeast and Mid-Atlantic**

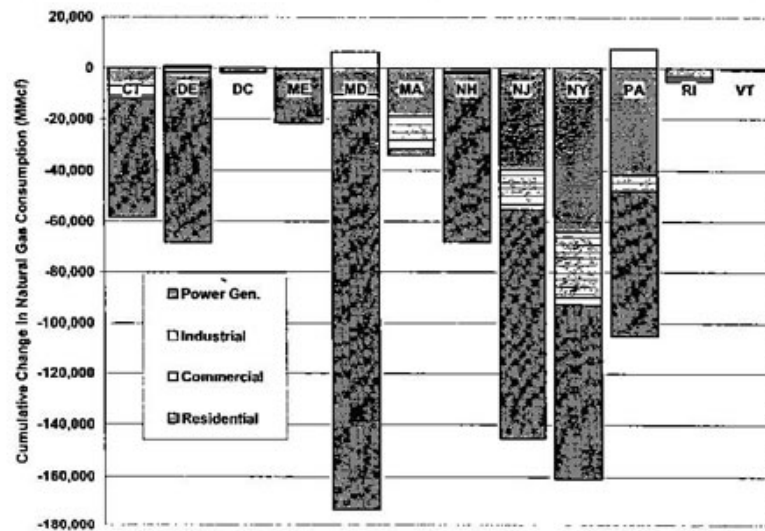


Figure 19. Historical and Projected Average Annual Retail Natural Gas Prices in the New England / Mid-Atlantic Region for both Base and Scenario Cases

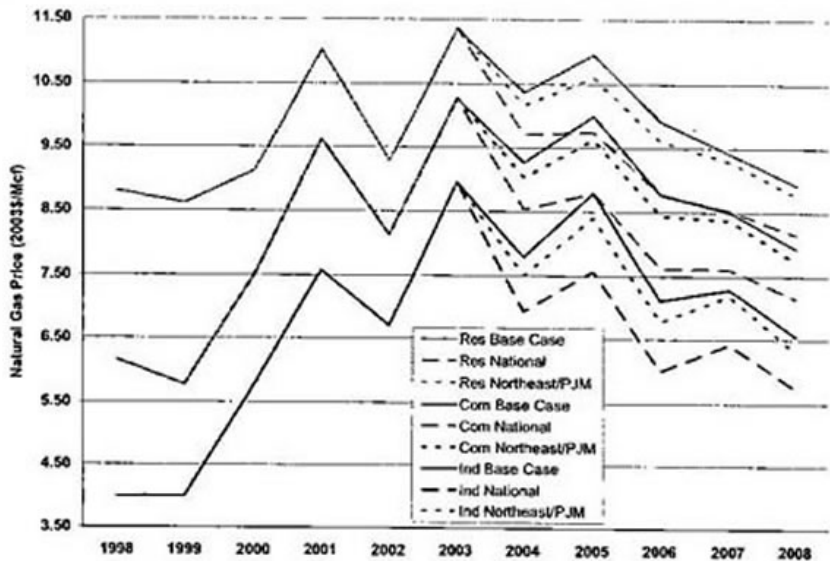
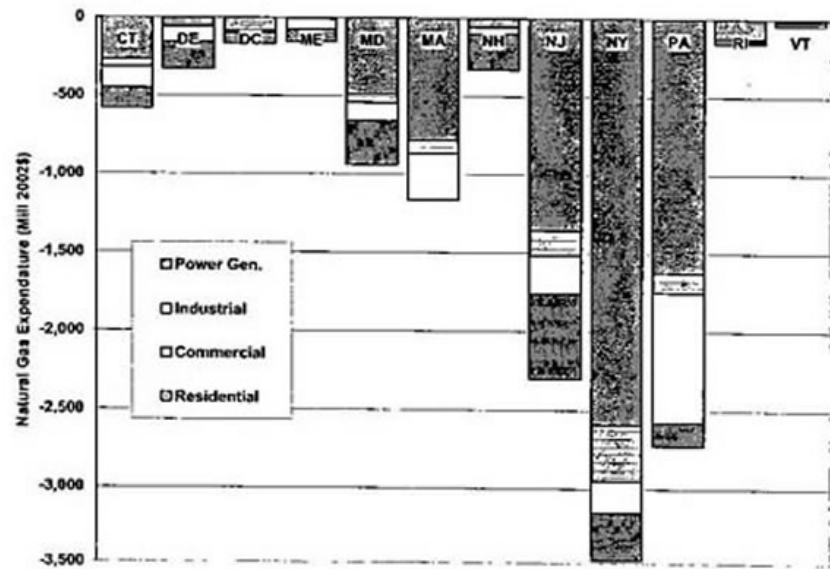


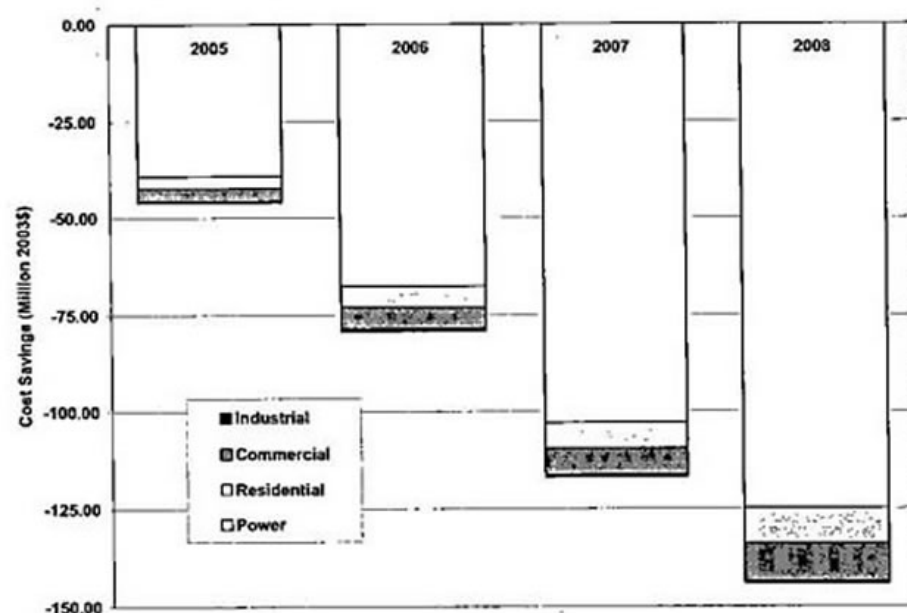
Figure 20. Cumulative Change in Natural Gas Expenditures by Sector in New England and the Mid-Atlantic Region



# Expanded Renewables in New York State Would Reduce Gas Prices

In the most geographically narrow scenario, we expand only renewable energy generation in New York State from 5.9% of total generation to 8.7% in 2008. This increase in renewables share would displace 19 Bcf in electric generation fuel and reduce the New York City wholesale price by almost 2%. The combined savings in natural gas expenditures resulting from expanded use of renewables in New York State would increase from about \$46 million in the first year of expanded renewables, 2005, to about \$144 million in 2008 (see Figure 21). In the power sector, natural gas expenditures would be reduced by almost \$125 million in 2008 from a combination of a 5% reduction in consumption of gas for power production and a 1.4% reduction in pricing to electricity generators. Overall expenditures by retail residential, commercial, and industrial customers would be reduced 0.25% for a savings of \$19 million in 2008. As the share of renewable power generation expands, this saving would continue to increase as well.

**Figure 21. Impact of Expanded Renewables in New York**

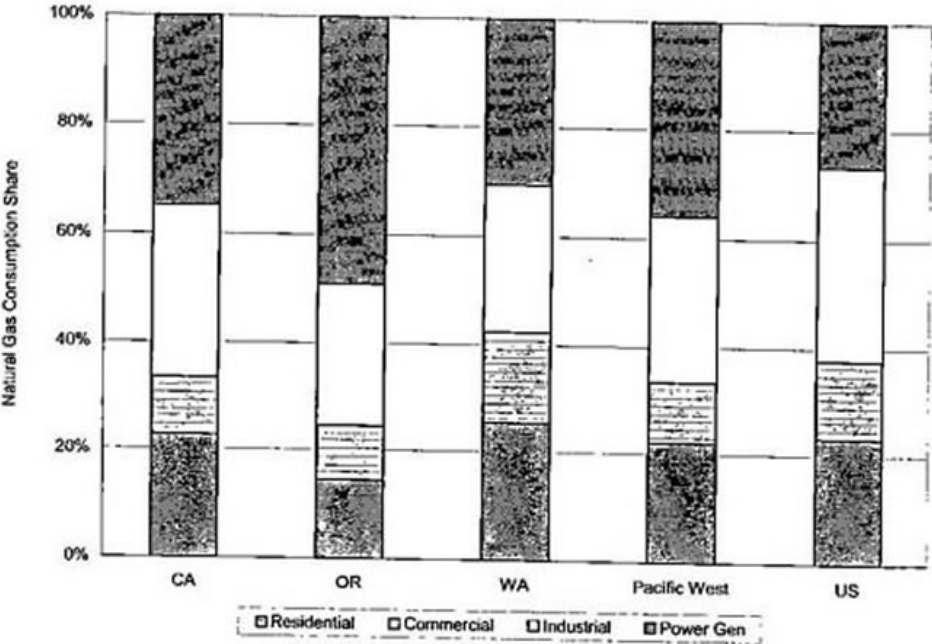


## *Pacific West*

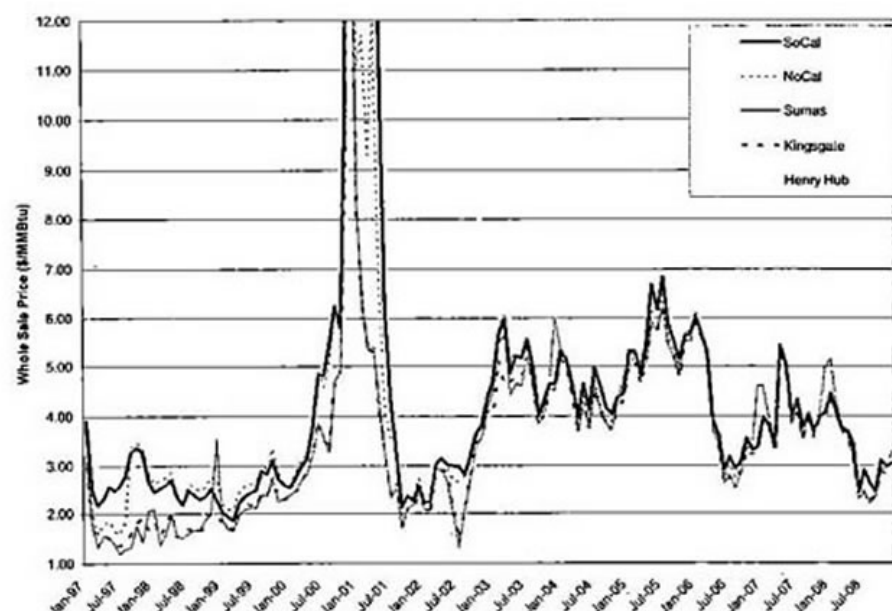
Natural gas consumption in the Pacific West region (California, Oregon and Washington) in 2002 was dominated by California which accounts for 79% of the gas consumed in the region and almost 10% of the national consumption (Figure 22). Distribution of use in the region is fairly similar to the national average, with residential use representing slightly more than 20% and industrial about 25%, almost identical to the national average. Commercial usage is somewhat less than the national average while gas use for power generation was somewhat greater. Within the region, power generation (as a percentage of natural gas use) was most dominant in Oregon where it accounted for about half of the total. Commercial gas

consumption (as a percentage of state total consumption) was greatest in Washington State, while the power generation was the lowest.

Figure 22. Share of Natural Gas by End-Use Sector for the Pacific West Region compared to the National Average



Historically the wholesale price of natural gas in the Northwest has been somewhat lower, particularly at the points of price excursions compared with the Henry Hub and prices in Southern California. The moderation in the northwest occurs because the northwest is tied to the Canadian producing regions by two import hubs (Kings Gate and Sumas – see map in appendix for locations). The wholesale prices are also somewhat moderated in Northern California compared with Southern California, where prices track Henry Hub except during excursions. The EEA projection is for prices in the west to moderate to the \$3-4 per MMBtu range after a few more years on volatility (Figure 23).

**Figure 23. Wholesale Natural Gas Prices in Pacific West**

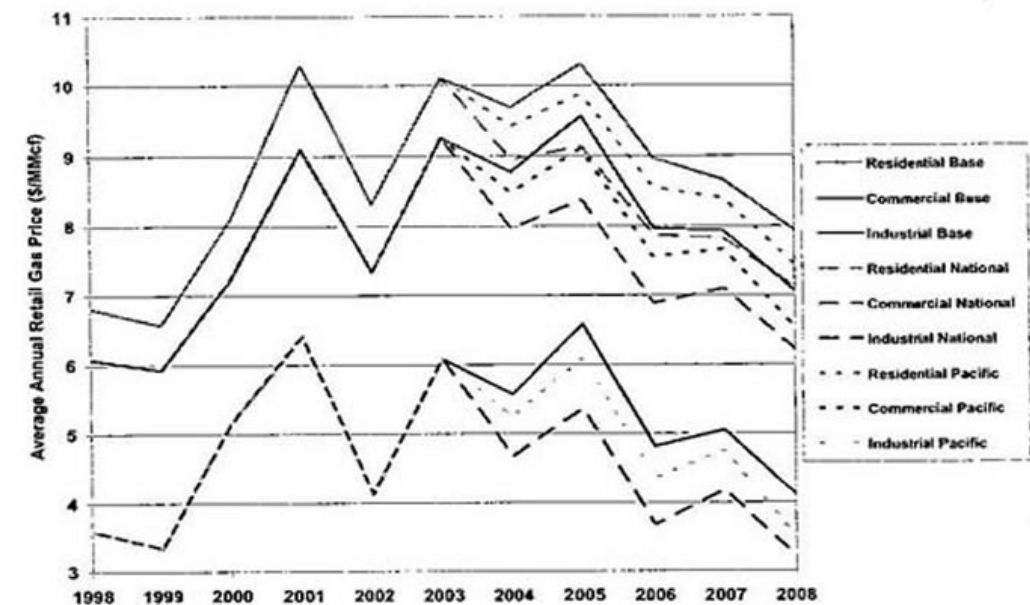
The lower wholesale prices in Washington and Oregon translate into lower residential, commercial and industrial retail price of natural gas compared to California (Table 16). Northwest prices have been at or below the national average, while California prices are slightly above the national average. Prices for natural gas used in power generation are below the national average for Oregon, but above the national average for California and Washington. These price trends are projected to continue in the base case.

As with the New England and Mid-Atlantic region, in the Pacific West we can compare the results for both the National and the region only scenarios. Significant retail price reductions are achieved in all sectors. As can be seen in Figure 24, the application of energy efficiency and renewable energy measures in the region achieve 36% of the price reduction seen with lower-48 state application of the measures for the first four years, but achieved over 60% of the retail price reductions in 2008. Thus regional application of the measures would achieve for the region a significant share of the benefits that would result from national level application of efficiency and renewable energy investments.

**Table 16. Historical and Projected Average Annual Retail Natural Gas Prices (\$/MMcf) in the Pacific West Compared to the National Average (EEA 2003)**

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
<b>RESIDENTIAL</b>											
CA	6.92	6.62	8.21	10.43	8.34	10.13	9.70	10.32	8.91	8.61	7.88
OR	6.81	7.13	8.12	9.70	8.23	10.07	9.65	10.38	9.30	8.97	8.22
WA	5.84	5.88	7.16	9.79	8.22	9.97	9.54	10.24	9.14	8.81	8.04
Pacific West	6.81	6.57	8.08	10.30	8.32	10.11	9.68	10.31	8.97	8.66	7.93
US Average	6.83	6.68	7.80	9.68	7.86	9.86	9.16	9.77	8.71	8.24	7.76
<b>COMMERCIAL</b>											
CA	6.37	6.17	7.54	9.33	7.48	9.42	8.93	9.70	7.99	8.00	7.10
OR	5.25	5.66	6.48	7.99	6.54	8.44	8.02	8.83	7.62	7.45	6.66
WA	4.76	4.89	6.02	8.62	7.11	8.93	8.49	9.28	8.06	7.88	7.06
Pacific West	6.08	5.93	7.22	9.09	7.33	9.25	8.77	9.56	7.97	7.93	7.05
US Average	5.56	5.38	6.71	8.56	6.95	9.00	8.25	8.98	7.76	7.49	6.94
<b>INDUSTRIAL</b>											
CA	3.75	3.33	5.29	6.60	4.07	6.00	5.49	6.50	4.69	4.92	4.00
OR	3.75	4.01	4.93	6.09	4.95	7.04	6.50	7.54	5.92	6.19	5.22
WA	2.64	2.82	4.01	5.02	3.88	5.94	5.43	6.46	4.83	5.10	4.09
Pacific West	3.60	3.34	5.15	6.41	4.13	6.08	5.57	6.58	4.81	5.05	4.11
US Average	3.24	3.26	4.69	5.76	4.79	6.77	6.00	7.02	5.35	5.58	4.83
<b>POWER GEN</b>											
CA	2.79	2.76	5.88	9.38	6.18	8.19	7.68	8.73	6.79	7.12	6.16
OR	1.56	1.96	2.94	3.82	3.21	5.19	4.90	5.86	4.53	4.55	3.73
WA	3.44	3.39	5.19	6.01	4.90	7.02	6.68	7.56	6.28	6.27	5.42
Pacific West	2.74	2.74	5.63	8.73	5.66	7.68	7.25	8.31	6.49	6.77	5.84
US Average	2.45	2.66	4.56	5.31	4.22	6.29	5.59	6.69	4.82	5.21	4.42

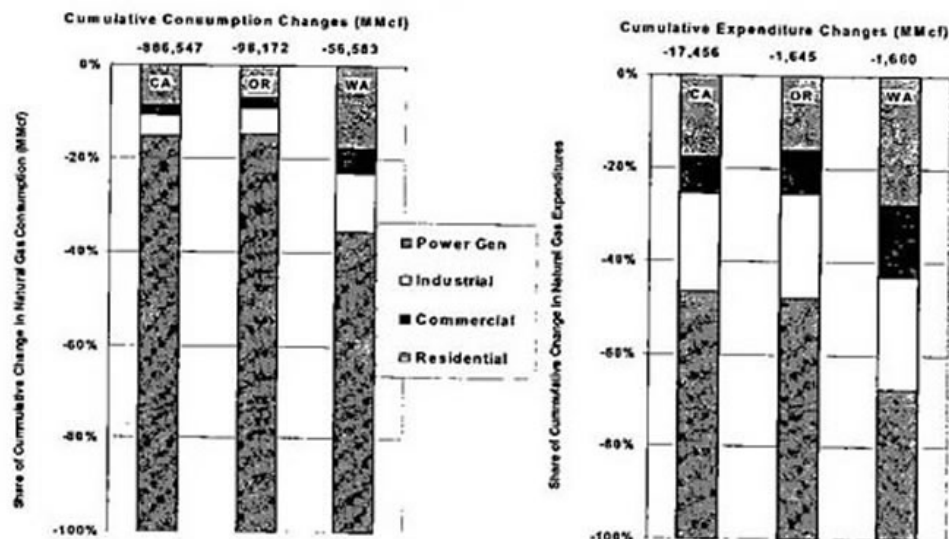
Figure 24. Historical and Projected Average Annual Retail Natural Gas Prices in the Pacific West Region for both Base and Scenario Cases



In the national scenario results in a 3.1% reduction in gas consumption in 2004, increasing to more than a 10% reduction in 2008. The cumulative consumption reduction is dominated by reductions in the power generation sector (Figure 25) resulting from electric efficiency and conservation, and expanded renewable power generation. Power generation accounts for more than 80% of the consumption reductions in California and Oregon, and more than two thirds of the reduction in Washington State. On the natural gas expenditures side, power generation still remains the dominant source of reduction though less so than with consumption. Power generation accounts for slightly more than half of the cumulative savings in California and Oregon, and about a third of the savings in Washington State. Industry accounts for about a fifth of the savings in all states, while residential savings over a quarter in Washington State, but less than a fifth in the other states.



**Figure 25. Cumulative Change in Consumption and Expenditures in the Pacific West Region from National Application of Energy Efficiency and Renewable Energy**



### ***Energy Efficiency and Renewable Energy Reduce Consumer Energy Expenditures***

Implementation of expanded energy efficiency and renewable energy result in a significant change in energy expenditures by end-use consumers (i.e., residential, commercial and industrial). These changes in expenditures come from five effects:

- Changes in natural gas prices resulting from the market effects discussed previously
- Changes in natural gas consumption resulting from natural gas energy efficiency measures
- Changes in electricity gas prices resulting from the reduced price of natural gas and increased use of renewables
- Changes in electricity consumption resulting from electric energy efficiency measures
- Changes in consumption of both gas and electricity due to changes in economic activity (This effect is most noticeable in the industrial sector of state with significant gas-intensive industries)

Unfortunately the analysis in this study does not allow the relative effects of each of these elements to be discretely determined because of the limited set of scenarios that were modeled and because of interaction between the various elements.

In addition, expenditures for natural gas by the power generation sector are also reduced as a result of reduced natural gas prices and because natural gas generation is displaced by electric efficiency and renewable generation. Because electric power markets are regional in

most of the lower-48 states, this analysis cannot attribute these savings to the end-user consumers in individual states.

*Changes in Natural Gas Expenditures – National Scenario*

The analysis does produce a detailed estimation of aggregate changes in natural gas expenditures by sector and by state. The total net changes in end-use consumer expenditures for gas are presented in Table 17.

**Table 17. Total Net Reductions (2004–2008) in End-Use Consumer Gas Expenditures (Million Dollars)**

	Residential	Commercial	Industrial	Total		Residential	Commercial	Industrial	Total
AL	253	113	839	1,206	NE	210	111	148	470
AZ	226	159	65	450	NV	186	126	19	333
AR	259	169	395	825	NH	49	52	39	140
CA	3,098	-1,336	3,714	8,149	NJ	1,354	916	239	2,510
CO	594	250	254	1,098	NM	224	157	39	421
CT	269	280	133	683	NY	2,585	2,080	208	4,874
DE	54	27	101	183	NC	364	204	294	862
DC	84	94	-	178	ND	60	50	94	206
FL	81	233	283	598	OH	1,877	870	1,264	4,012
GA	715	245	521	1,482	OK	343	185	478	1,006
ID	110	62	116	289	OR	263	153	370	787
IL	2,684	993	1,138	4,816	PA	1,621	740	828	3,190
IN	928	439	1,177	2,545	RI	125	82	15	223
IA	404	207	375	986	SC	160	98	301	560
KS	361	168	380	910	SD	67	45	14	128
KY	363	179	411	954	TN	385	250	520	1,157
LA	265	118	3,066	3,451	TX	1,141	949	8,109	10,201
ME	7	17	63	88	UT	297	168	127	593
MD	492	300	117	910	VT	18	16	18	53
MA	782	468	294	1,545	VA	495	373	251	1,120
MI	1,982	905	908	3,796	WA	456	262	397	1,116
MN	742	458	411	1,612	WV	148	122	169	440
MS	179	111	429	721	WI	808	425	621	1,855
MO	591	279	258	1,128	WY	76	66	101	244
MT	110	62	36	209	US	28,964	16,196	30,151	75,311

Table 18 displays what this national scenario would mean specifically for individual residential gas customers. The data in this table represents the average annual natural gas bill reduction per residence with gas service. While these are annual savings numbers, the great majority of these savings would be obtained during the peak winter heating season when residential consumer gas consumption and bills are the highest.

Table 18. Average Annual Natural Gas Expenditure Change per Residential Natural Gas Customer (\$/customer)

	Number of Natural Gas Residential Consumers	2004	2008	5-Year Avg.		Number of Natural Gas Residential Consumers	2004	2008	5-Year Avg.
AL	807,245	-47	-54	-63	NE	476,275	-70	-78	-88
AZ	884,789	-40	-47	-51	NV	550,850	-53	-69	-68
AR	552,716	-70	-85	-94	NH	84,760	-85	-111	-116
CA	9,600,493	-52	-61	-65	NJ	2,436,771	-79	-100	-111
CO	1,365,594	-77	-76	-87	NM	485,969	-70	-88	-92
CT	458,105	-85	-112	-118	NY	4,243,130	-90	-112	-122
DE	122,829	-65	-78	-88	NC	891,227	-58	-72	-82
DC	138,412	-90	-107	-122	ND	106,758	-89	-99	-114
FL	590,221	-22	-24	-28	OH	3,195,407	-87	-101	-118
GA	1,737,850	-62	-68	-82	OK	868,314	-62	-67	-79
ID	251,004	-70	-84	-88	OR	542,799	-73	-87	-97
IL	3,670,693	-111	-128	-146	PA	2,542,724	-94	-116	-127
IN	1,613,373	-85	-101	-115	RI	216,781	-85	-110	-116
IA	818,313	-76	-85	-99	SC	501,161	-45	-56	-64
KS	836,486	-68	-73	-86	SD	144,310	-72	-81	-94
KY	749,106	-70	-84	-97	TN	993,363	-56	-68	-78
LA	952,753	-42	-49	-56	TX	3,738,260	-47	-53	-61
ME	17,302	-59	-76	-80	UT	657,728	-80	-81	-91
MD	959,772	-77	-92	-103	VT	29,463	-89	-114	-122
MA	1,283,008	-89	-116	-122	VA	941,582	-78	-97	-105
MI	3,011,205	-98	-111	-132	WA	841,617	-82	-95	-108
MN	1,249,748	-90	-100	-119	WV	363,126	-60	-69	-82
MS	437,899	-62	-77	-82	WI	1,484,536	-82	-95	-109
MO	1,326,160	-69	-77	-89	WY	129,897	-105	-110	-118
MT	226,171	-76	-85	-98	US	60,252,745	-73	-86	-96

*Changes in Electricity Expenditures*

The EEA model used in this study does not directly provide estimates of changes in end-use consumer expenditures for electricity. Thus, ACEEE undertook an indirect approach to obtain an approximation of the end-user electric savings.

The electric power sector experiences a significant reduction in expenditures for natural gas because of decreases in natural gas prices and reduced consumption of gas. These consumption reductions occur because overall demand for electricity is reduced as a result of increased energy efficiency and conservation by end-use consumers, and because a portion of the remaining natural gas generation is displaced by new renewable generation. Changes in natural gas expenditures by the power sector in each of the lower-48 states are presented in Table 19.

It is important to keep in mind that with the exception of Texas (for all practical purposes has an autonomous grid), all other states are part of broad regional markets so that the changes in gas consumption in the power sector in a state may actually result from reductions in electricity demand and increased renewables in other states. As a result, these "savings" from the power sector in a state may not solely benefit the electricity consumers in that state. A portion of these expenditure reductions are likely to be passed along to end-use electricity consumers in the form of lower rates. Another portion is likely to be used to offset the costs associated with procurement of new renewable power generation. The analysis and modeling do not allow for an apportioning of these expenditure changes to price reductions at either the state or national level. In addition, some states that have undergone restructuring have frozen retail rates (for at least some customer classes) so these savings would not be passed along to consumers. The reductions in power generation gas expenditures should be viewed as the upper limit on savings to end-use consumers from electricity price reductions. However, these expenditure reductions do, represent an important benefit at the regional and national level in the evaluation of the cost/benefit relationship of energy efficiency and renewable energy on natural gas markets.

**Table 19. Reductions in Natural Gas Expenditures in the Power Sector (Million 2002\$)**

State	2004	2008	Cum.	State	2004	2008	Cum.
AL	133	385	1,377	NC	48	126	482
AR	27	38	213	ND	0	0	1
AZ	162	127	747	NE	3	21	79
CA	1,090	2,312	9,306	NH	2	3	16
CO	55	24	172	NJ	183	234	1,027
CT	67	129	528	NM	38	37	192
DC	0	0	0	NV	231	730	2,491
DE	40	170	493	NY	431	545	2,499
FL	648	1,026	4,655	OH	-70	-53	-350
GA	130	263	1,106	OK	84	90	508
IA	2	23	75	OR	144	179	857
ID	21	38	155	PA	67	326	828
IL	89	129	581	RI	85	149	643
IN	-11	-3	-55	SC	38	82	351
KS	18	18	104	SD	-1	15	62
KY	35	94	352	TN	37	103	371
LA	124	147	802	TX	1,550	1,805	8,413
MA	176	280	1,283	UT	27	29	127
MD	37	82	304	VA	25	54	213
ME	71	69	403	VT	1	1	7
MI	99	86	501	WA	100	110	543
MN	8	45	169	WI	28	31	151
MO	23	94	310	WV	-10	-10	-62
MS	48	102	510	WY	5	6	27
MT	28	75	269	US-Total	-1,896	727	24,361

End-use consumers do directly benefit from expenditure reductions that result from reduced consumption energy efficiency and conservation. Assuming no direct electricity price impacts beyond the base case, this analysis projects consumers would reduce their electricity bills cumulatively by \$4.24 billion for the 2004-2008 modeling period. This reduction

represents a 2.5% change in 2004, rising to 4.9% by 2008. Cumulative changes in end-use consumer electric expenditures by state and sector are presented in Table 20. Annual values can be found in Appendix C.

**Table 20. Cumulative Electricity Expenditure Reductions (2004-2008) in Million 2002\$<sup>1</sup>**

STATE	Residential	Commercial	Industrial	Total End-Users	STATE	Residential	Commercial	Industrial	Total End-Users
AL	23.0	15.8	14.4	53.2	NC	44.8	31.6	17.7	94.1
AR	14.0	7.5	8.8	30.3	ND	2.6	2.5	1.3	6.4
AZ	33.7	27.4	8.0	69.0	NE	6.6	5.3	3.2	15.1
CA	207.4	299.8	86.8	594.1	NH	8.4	8.5	4.0	20.9
CO	15.9	17.1	6.5	39.5	NJ	54.8	74.0	21.4	150.2
CT	27.3	27.9	8.9	64.1	NM	5.3	6.8	3.0	15.1
DC	1.9	9.7	0.2	11.8	NV	13.5	9.5	9.8	32.9
DE	4.7	4.2	2.5	11.4	NY	129.8	182.3	28.5	340.7
FL	139.4	87.0	15.2	241.6	OH	58.8	55.7	40.9	155.3
GA	52.4	41.6	22.1	116.1	OK	17.2	11.4	6.8	35.4
IA	14.4	11.8	12.3	38.5	OR	22.7	19.4	10.5	52.6
ID	7.4	6.9	4.4	18.7	PA	65.6	57.9	40.1	163.6
IL	65.6	64.7	33.7	164.1	RI	6.9	9.0	2.7	18.6
IN	36.8	27.4	31.2	95.4	SC	22.8	14.7	14.5	52.1
KS	10.9	10.6	5.7	27.2	SD	3.1	2.6	0.9	6.5
KY	15.8	9.6	14.0	39.4	TN	35.1	26.8	19.6	81.4
LA	36.8	17.7	19.0	73.6	TX	229.9	163.6	110.3	503.7
MA	37.7	67.9	19.2	124.8	UT	8.0	9.4	4.2	21.7
MD	37.2	32.9	7.8	78.0	VA	44.1	28.3	12.3	84.7
ME	10.6	11.6	4.7	27.0	VT	5.3	5.3	2.7	13.2
MI	39.6	43.9	25.6	109.1	WA	31.7	26.4	14.9	73.0
MN	26.8	24.7	16.6	68.1	WI	34.2	28.2	23.5	85.9
MO	24.8	20.6	8.1	53.5	WV	7.3	4.8	4.9	17.1
MS	14.7	10.1	8.0	32.8	WY	2.1	2.7	3.5	8.3
MT	3.9	3.8	2.9	10.6	US-Total	1,763.6	1,688.9	788.2	4,240.7

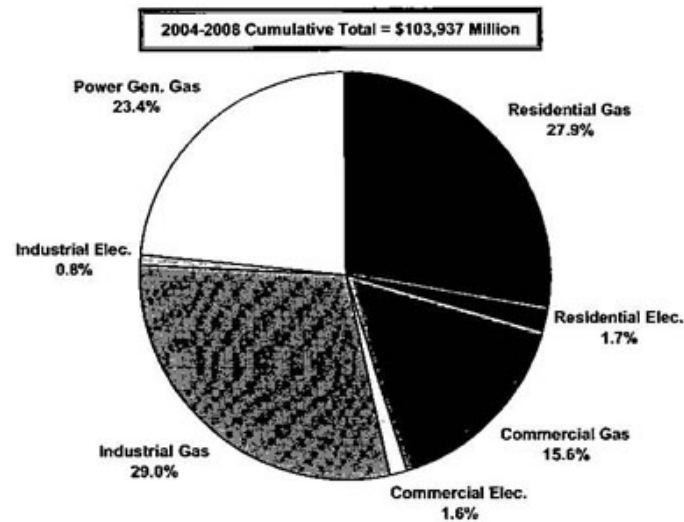
<sup>1</sup>Note: These changes in electricity expenditures are calculated from the projected base-case electricity price by state and sector, and reductions in electricity consumption provided as an input to the model. No attempt was made to account for changes in electricity prices resulting from the effects of the energy efficiency or renewable energy policies.

#### *Cumulative Changes in Energy Expenditure*

The proposed energy efficiency and renewable energy expansion proposed in this study produce cumulative energy expenditure reductions for natural gas and electricity of almost \$104 billion for the five year study period. The \$30,170 million in industrial gas expenditure reductions account for largest share of the savings (29% of the total), followed closely by residential sector (27.8% or \$28,966 million) (see Figure 26). These expenditure reductions however come from different market effects. In the industrial sector, most of the expenditure

reductions occur from the average 16.4% reduction in the natural gas price while actual industrial consumption increases modestly as was discussed above. More of the residential savings results from the 3.1% reduction in consumption in 2008 resulting from energy efficiency and conservation, rather than the 10% average reduction in residential natural gas prices. Electric power generation reduces natural gas by \$24,361 million (23.4% of cumulative reductions) with these reductions resulting from a reduction in consumption that rises to over 15% by 2008 and an average 18.8% reduction in price. The \$ 1,689 million reduction in commercial natural gas (15.6% of the total) results from a modest reduction in consumption and an average 11.6% reduction in natural gas pricing for the sector. The electric expenditure reductions from reduced consumption in all of the end-use sectors account for 4.1% of the total national expenditure reductions.

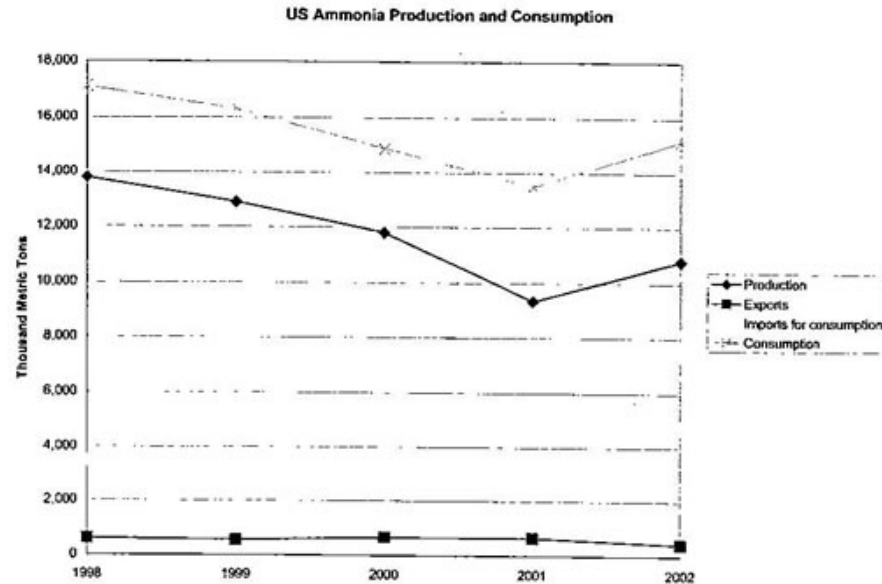
**Figure 26. Total Net Energy Expenditure Reductions (2004-2008) from Expanded Energy Efficiency and Renewable Energy**



### Renewable Energy and Energy Efficiency Can Lower the Cost of Natural Gas, Fertilizer, and Crops

#### Introduction

Volatile and high prices for natural gas are having serious repercussions in the U.S. fertilizer industry, and by extension, are raising production costs for farmers. Since natural gas accounts for the bulk of raw material costs for fertilizer, price spikes for natural gas result in price spikes for fertilizer. In 2001, when gas prices rose to \$10 per million BTU, fertilizer prices more than doubled. The result is plant closures by American producers, increased fertilizer imports from abroad and higher production costs for farmers.

**Figure 27. Ammonia Production and Consumption**

Aggressive policies to promote renewable energy and energy efficiency can reduce the price of natural gas by lowering demand, especially gas used for electric power production. Modeling by ACEEE and EEA finds that efficiency improvements in furnaces, appliances, and industry, along with rapid increases in cost-effective renewable energy (such as wind power), can reduce wholesale gas prices by 20 percent, resulting in a significant reduction of fertilizer costs. This will modestly reduce corn production costs, increasing profits in a very low-margin business.

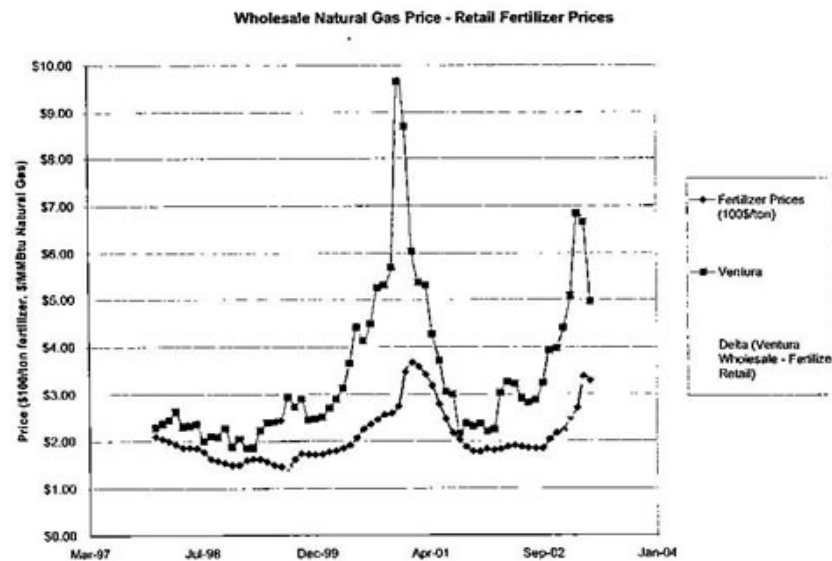
#### ***Nitrogenous Fertilizer Trends***

Nitrogenous fertilizers utilize a large quantity of natural gas in their production. The cost of natural gas typically represents 70-90% percent of the raw material cost of producing anhydrous ammonia, one of the more commonly utilized nitrogenous fertilizers. Fertilizer production has been historically a low profit margin business, and higher gas prices have resulted in the shutdown of over 8 ammonia producing facilities in the US since 2001. Domestic production of nitrogenous fertilizers (Figure 27) was 25% lower in 2001 than 2000 (USGS 2003). Anhydrous ammonia production facilities are located close to central natural gas production and transmission hubs. The majority of ammonia is produced in the gulf coast region of the US.

The following table shows the amount of anhydrous ammonia produced and consumed in the US. Both domestic consumption and production decreased significantly between 1998 and 2001. A slow, but steady increase in fertilizer imports is continuing, while exports are slowly decreasing.

In January 2001, when Henry Hub spot price for natural gas rose to well over \$10/MMBtu, the spot price for anhydrous ammonia increased by 144%, from \$119 to \$290 per ton (GAO 2003). The wholesale spot market price of ammonia closely follows that of natural gas. The following chart shows the wholesale price of natural gas at the Ventura hub (located in Iowa) and the retail price of ammonia paid by Iowa farmers. The retail price of ammonia tends to follow a similar curve as the price of natural gas, but with a 2-3 month delay (Figure 28).

**Figure 28. Gas Price and Ammonia Price**



The decline in ammonia production due to plant closures, coupled with the increased retail price in domestically produced ammonia, resulted in a significant increase in the retail price paid by farmers for ammonia-based fertilizer. Farmers, who are the primary consumers of anhydrous ammonia fertilizer, were somewhat sheltered from the spot market price spikes for ammonia. The volatility of retail ammonia price was somewhat dampened because of the 43% increase in imports (primarily from Canada and Trinidad and Tobago). Farmers also have some control over their need for nitrogenous fertilizer. There are several farming techniques that can be employed during periods of fertilizer price spikes that can lessen the need for fertilizer.



***Impact on Farmers and Corn Production***

Nitrogen is a necessary nutrient in soil for the production of corn and other crops. When the retail price of fertilizer increases, the cost of corn also increases to compensate for the increased costs of production. There are several fixed and variable costs incurred by farmers during the production of corn. Fixed costs included items such as land, machinery, and labor. The variable costs of corn production include the cost of seed, fertilizers, and pesticides. Pesticide costs have also increased along with the price of natural gas, though much less dramatically.

In the typical production of silage corn, fixed costs are between \$230 and \$290 per acre of harvested corn (or \$12 to \$15 per ton). Variable costs are between \$190 and \$230 per acre (or \$10 to \$12 per ton). Nitrogen costs range from \$28 to \$38 per acre, depending on the productivity level of the soil. Nitrogen represents between 6.6 and 7.3% (\$1.65 to \$1.80 per ton) of the cost of silage corn production. A doubling in the retail price of nitrogenous fertilizer, as occurred in the spring of 2001, can increase the price of corn production by about 7% (Iowa State University 2003).

Even seemingly small increases in production costs such as these can have a tremendous impact on farmers, since profit margins in corn production are miniscule. When the price of ammonia is anticipated to be higher than normal, farmers have employed crop rotation techniques as well as utilizing alternate nitrogen sources such as manure to maintain high crop yields.

***The Impact of Efficiency and Renewable Energy on Gas, Fertilizer, and Corn Production Costs***

Modeling by ACEEE and EEA ("Impacts of Energy Efficiency and Renewable Energy on Natural Gas Markets," <http://aceee.org/energy/efnatgas-study.htm>) found that a package of policies and programs aimed at increasing energy efficiency and renewable energy production could reduce natural gas demand by 4.1 percent over the next five years, reducing prices by 22 percent, and saving American consumers \$75 billion. This reduction in natural gas prices would provide a significant boost to domestic natural gas production, protecting American jobs, and reducing fertilizer costs to farmers.

These policies would see other direct and indirect benefits for farmers as well. Wind power developers, for example, pay farmers and ranchers between \$2000 and \$5000 per turbine per year to site turbines on their land. This typically takes a quarter acre out of production for each turbine, but allows continued use of the rest of the land for crops and grazing. (See National Wind Coordinating Committee, "Assessing the Economic Development Impacts of Wind Power," March 2003, [http://nationalwind.org/pubs/economic/econ\\_final\\_report.pdf](http://nationalwind.org/pubs/economic/econ_final_report.pdf)). Likewise, programs that encourage the use of more efficient motors, pumps, and refrigeration systems can help farmers reduce electricity costs.

***Analysis of Investment and Program Costs***

Analysis of the consumer and programmatic costs of delivering the energy efficiency and renewable energy improvements described earlier shows a very favorable cost-to-benefit

ratio. Implementation of efficiency and renewables across the United States would cost consumers just over \$23 billion over five years (see Figure 29 and Table 21). Significant programmatic support would be necessary however to achieve the savings. An additional \$7.2 billion would be required from programmatic administration offices such as state energy offices, public benefit funds, and the federal government. A nation-wide effort would require a total societal investment of just over \$30 billion. As presented in the previous section, these levels of investment would save consumers over \$100 billion over the next five years. For every dollar invested, \$3.44 would be gained in reduced consumption and energy bills. From the public expenditure perspective, the total program costs of just over \$7 billion would produce \$14.71 of benefit for each program dollar.

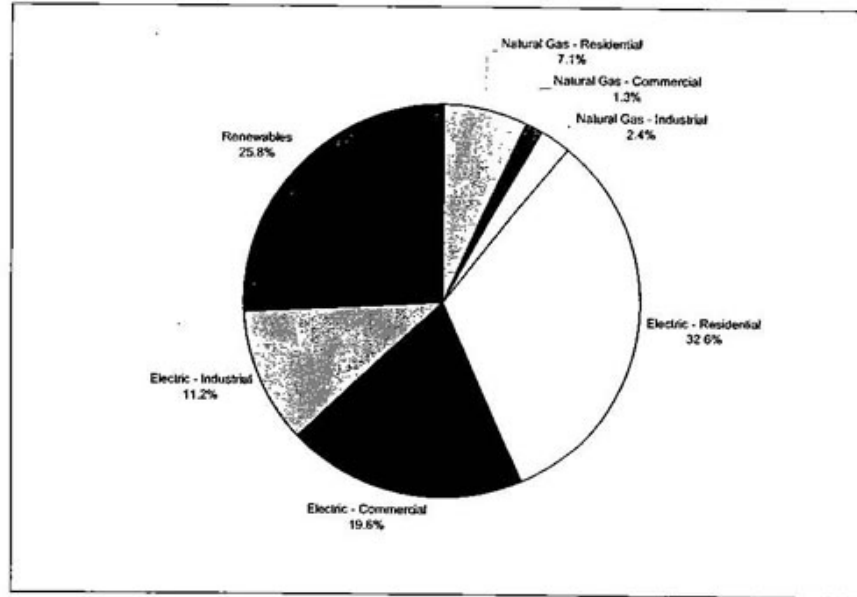
#### *Summary of Costs for Efficiency and Renewable Energy*

Table 21 and Figure 29 show how investment and program costs must be allocated in order to achieve the savings described earlier. Nearly two-thirds (64%) of the total investment will have to be made in the areas of electric efficiency, with half of those electric efficiency investments being made in the residential sector. The end-use natural gas savings will require only 11% of the total investment. Overall, the residential efficiency investments account for about 40% of the total required investment. Just over a quarter of the total investment is required to meet the renewable market share for all of the regions specified in the national scenario.

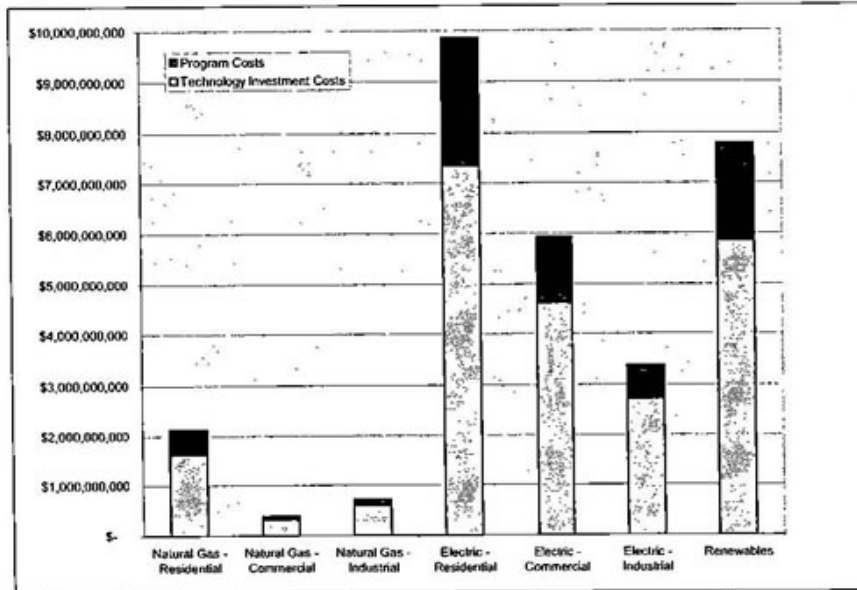
**Table 21. Costs of Implementing Energy Efficiency and Renewable Energy**

<b>Sector</b>	<b>Technical Investment Costs</b>	<b>Program Costs</b>	<b>Total Cost</b>
Natural Gas - Residential	\$1,623,514,825	\$514,062,322	\$2,137,577,147
Natural Gas - Commercial	\$314,589,436	\$81,180,475	\$395,769,910
Natural Gas - Industrial	\$602,709,583	\$124,440,731	\$727,150,313
<b>Total Natural Gas</b>	<b>\$2,540,813,843</b>	<b>\$719,683,528</b>	<b>\$3,260,497,371</b>
Electric - Residential	\$7,341,513,564	\$2,521,965,439	\$9,863,479,003
Electric - Commercial	\$4,617,018,241	\$1,322,652,656	\$5,939,670,897
Electric - Industrial	\$2,726,631,713	\$651,168,588	\$3,377,800,301
<b>Total Electric</b>	<b>\$14,685,163,518</b>	<b>\$4,495,786,683</b>	<b>\$19,180,950,201</b>
<b>Renewables - \$0.045/kWh Installed</b>	<b>\$5,851,457,683</b>	<b>\$1,950,485,894</b>	<b>\$7,801,943,577</b>
<b>Total Cost of Efficiency and Renewables</b>	<b>\$23,077,435,044</b>	<b>\$7,165,956,105</b>	<b>\$30,243,391,149</b>

**Figure 29. Distribution of Technical Investment and Program Costs to National Implement Energy Efficiency and Renewable Energy Scenario**



Overall, the program costs represent about 24% of the total cost required to implement the national scenario. The program share of the total costs varies by the sector. Figure 30 displays both the magnitude of total investment in each sector as well as the ratio of consumer-borne technical investment costs and the programmatic costs. For energy efficiency, the programmatic costs as a percentage are highest in the residential sector (25% of total costs), followed by the commercial (22%) and industrial (19%) sectors. The high program cost for residential results from the need to work with many small consumers to obtain significant energy reductions, in contrast to the commercial and industrial sectors where contacts can be more efficiently made with the largest energy users. For renewables, the program costs average about 25%, in large part because of the incentives specified under the policy section.

**Figure 30. Investment and Program Costs of Energy Efficiency and Renewable Energy**

It is important to note that while the economics of efficiency and renewables are attractive for consumers; these savings will require an up-front investment on the part of both consumers and program administrators. Without the programmatic support to educate the consumer and create an attractive market for efficiency and renewable products, very little of this potential will be achieved. Furthermore, the cost of administering the efficiency and renewable programs will be higher in states with little or no experience in delivering such services to their consumers. To account for the differences in administrative experience among the various states, it was assumed that an "a" state would incur no additional charges beyond its standard sector-based administrative adder. A "b" state would incur 5% in additional costs, a "c" state would incur 10%, and a "d" state would incur 15%.

#### *Sector Cost Methodologies*

Because the estimates for achievable savings potential were different for each sector, the approaches to estimating the costs were different. As with the savings potential natural gas and electric efficiency costs estimates were made on a state basis, while renewable energy costs were made at the regional level. The next sections discuss how the costs estimates were made.

#### *Residential and Commercial Sector Methodologies*

Estimated costs for energy efficiency were based on the average cost per saved Therm of end-use gas and average cost per saved kWh from leading utility and state energy efficiency